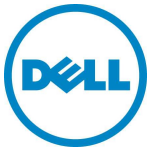

DVS Enterprise

Reference Architecture

VMware Horizon View Reference

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1 Introduction

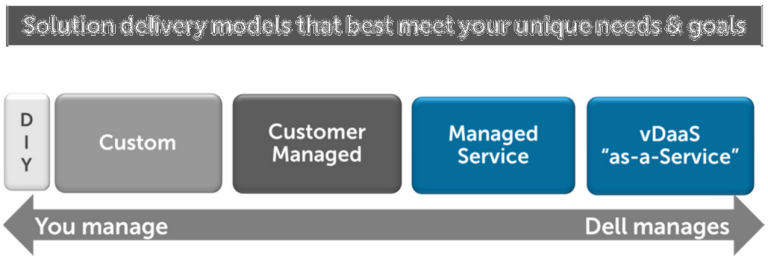
Desktop Virtualization Solutions Overview

Dell Desktop Virtualization Solutions offers a comprehensive solution portfolio designed to deliver the benefits of virtual end user and Cloud Client Computing. While there are several ways of delivering virtual desktops, this solution is built on the Virtual Desktop Infrastructure (VDI) model. In a VDI environment, user desktops are hosted as virtual machines (VMs) in a centralized infrastructure and delivered over a network to an end user's client device.

Getting the most out of a VDI infrastructure requires a well-developed, reliable architecture. If the VDI architecture is undersized in terms of processing, memory or storage, then performance will suffer and the experience will be less user-friendly than a traditional PC. If the architecture is oversized, then the cost per virtual desktop will be economically unfeasible for VDI adoption.

In order to enable Dell to compete efficiently in the VDI space and to accelerate the sales cycle, a Solution Source Architecture (SSA) approach has been developed. This approach offers a tested methodology that accelerates time to benefit and increases operating efficiency for our customers.

Our extensively pre-tested Dell Desktop Virtualization Solutions leverage purpose-built hardware, software and services ingredients to enable a "capable" architecture that maximizes IT control while enhancing the end user experience. Dell utilizes industry standard ingredients so that our customers have a clear path to expedient upgrades and full support through the life of this open solution without sacrificing choice and flexibility. Dell invests in extensive R&D and solution validation to ensure that our customers experience a fine-tuned deployment process that leads to deterministic operational costs. Coupled with Dell's ability to offer a subscription-based Desktop-as-a-Service option to minimize your capital costs, Dell makes its leading desktop virtualization solution more affordable for you.



The DVS Enterprise Solution Today

Dell Desktop Virtualization Solutions deliver a range of purpose-built horizontal architectures. These architectures are designed and battle-tested to be modular and scalable for an array of customer needs and a defined and tested services methodology. To provide a simplified solution stack, we have designed and enhanced the original DVS Enterprise solution to address the vast majority of customer needs and use cases for Desktop Virtualization. Simultaneously, we have worked to make the solution easier to deploy and scale.

Initially there were the ISS Enterprise and ISS Enterprise+ bundles; both with strict guidelines and constraints on sizing and scaling. Subsequently, the DVS Enterprise Solution has been refined and enhanced to be custom-tailored and sold as one cohesive stack known as DVS Enterprise. The solution now has the ability be sold initially as an entry level rack-based solution for as few as 50 users. Alternatively, the solution can either grow into or be customized and sold as a highly scalable, blade-based solution serving 50,000 users or more.

The DVS Enterprise solution is an architecture incorporating a VMware vSphere hypervisor with a Citrix XenDesktop desktop virtualization solution. On top of this foundation runs Dell's core architecture components for networking, compute and storage designed from a tested and effective selection of ingredients.

Product Positioning

The Dell Desktop Virtualization Solution is a prescriptive, highly scalable, flexible architecture designed to meet the wide array of VDI customer needs that exist today. The DVS Enterprise Solution has the ability to scale anywhere from 50 to 50,000 users with a high degree of prescription at every user level along the way. This granularity of scale allows customers to leverage Dell DVS's accurate pay-as-you-grow model and add VDI capability as their VDI needs increase.

	Minimum Base Configuration	Rack Server, Local Tier 1	Rack Server, Shared Tier 1	Blade Server, Shared Tier 1
Virtual Desktops	Yes	Yes	Yes	Yes
Redundancy	Optional	Yes	Yes	Yes
Recoverability	Optional	Yes	Yes	Yes
Live Migration	No	No	Yes	Yes
High Density	No	No	No	Yes

To provide this level of proven prescription, the DVS Enterprise leverages a core set of hardware and software components that have been tested and proven to provide optimal performance at the lowest cost per user. To provide this level of flexibility, the DVS Enterprise also includes an extended list of optional/upsell components that a customer can chose from for environments with unique VDI feature, scale or performance needs. Whether the customer requires a Managed Solution from Dell or prefers to manage the solution in-house, the tenants of the DVS Enterprise Solution remain consistent and will be leveraged as the horizontal platform. If the various approved configurations do not meet customer requirements, then a custom solution can be provided.

Feature Overview

1.4.1 Design Principles

The design principles for the flexible computing solution are:

- Flexible – Available with a choice of leading desktop solutions, including VMware Horizon View 5.2 and Xen Desktop 5.6
- Secure – Security risks, concerns and policies are addressed or mitigated
- Manageable – The solution includes the tools and software services required to manage the environment
- Standards-based – Makes use of commodity, off-the-shelf components wherever possible
- Distributed – Non-blocking and built with distributed components to maximize the use of available computing resources and eliminate bottlenecks
- Scalable – Capable of scaling up or down to support business needs
- Resilient – Capable of withstanding the failure of a single infrastructure component

1.4.2 Architecture Scalability

The architecture is designed to provide a scalable platform:

- The components can be scaled either horizontally (by adding additional physical and virtual servers to the server pools) or vertically (by adding virtual resources to the infrastructure).
- The architecture eliminates bandwidth and performance bottlenecks as much as possible.
- This scalability enables the reduction of the future cost of infrastructure ownership.

Component	Horizontal scalability	Vertical scalability
Virtual Desktop Compute Servers	Additional servers added as necessary	Additional RAM or CPU compute power

View Connection Servers	Additional physical servers added to the Management cluster to deal with additional management VMs	Additional network and I/O capacity added to the servers
VMware vCenter	Deploy additional servers and use linked mode to optimize management	Additional vCenter Management VMs
Database Services	Migrate databases to a dedicated SQL server and increase the number of management nodes	Additional RAM and CPU for the management nodes
File Services	• Split user profiles and home directories between multiple file servers in the cluster • File services can also be migrated to the optional NAS device for high availability	Additional RAM and CPU for the management nodes

2 The DVS Enterprise Solution Architecture

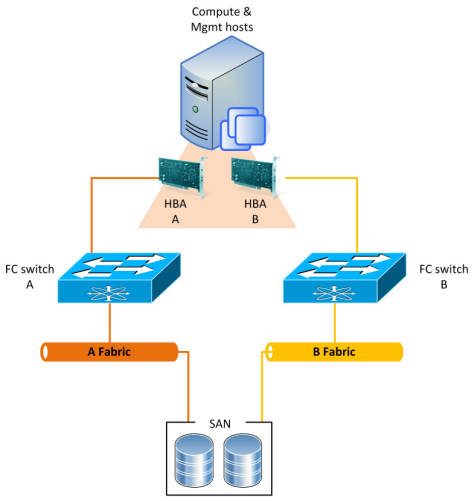
Storage Infrastructure

The leading cause of slow end-user experience in a VDI deployment is inadequate or poorly designed storage architecture. From the moment a user authenticates into a VDI environment, multiple tiers of the VDI storage architecture are being accessed, sometimes heavily. It is this reason that if any element of a storage array; network interface, disk speed, disk type, disk quantity, free space, or similar is not up to the task of supporting the workload associated with the user population, performance will suffer greatly and failures may occur. The DVS Enterprise solved these potential problems by providing storage options that exceed the performance and dollar-per-user requirements of customers and at the same time, provide additional storage options to custom-tailor performance and capacity characteristics to specific customer needs.

2.1.1 Compellent Fibre Channel

Based on Fluid Data architecture, the Dell Compellent Storage Center SAN provides built-in intelligence and automation to dynamically manage enterprise data throughout its lifecycle. Together, block-level intelligence, storage virtualization, integrated software and modular, platform-independent hardware enable exceptional efficiency, simplicity and security.

Storage Center actively manages data at a block level using real-time intelligence, providing fully virtualized storage at the disk level. Resources are pooled across the entire storage array. All virtual volumes are thin-provisioned. And with sub-LUN tiering, data is automatically moved between tiers and RAID levels based on actual use.



If Fibre Channel (FC) is the selected block storage protocol, then the Compellent Storage Center Integrations for the VMware vSphere client plugin is installed on all hosts. This plugin enables all newly created data stores to be automatically aligned at the recommended 4MB offset. Although a single fabric can be configured to begin with, as a best practice recommendation, the environment should be configured with two fabrics to provide multipathing and end-to-end redundancy.

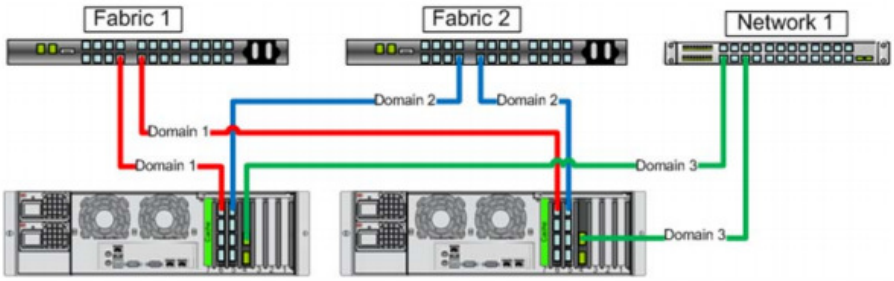
When using QLogic HBAs, the following BIOS settings should be used:

- The “connection options” field should be set to 1 for point to point only
- The “login retry count” field should be set to 60 attempts
- The “port down retry” count field should be set to 60 attempts
- The “link down timeout” field should be set to 30 seconds
- The “queue depth” (or “Execution Throttle”) field should be set to 255
- This queue depth can be set to 255 because the ESXi VMkernel driver module and DSNRO can more conveniently control the queue depth.

2.1.1.1 Zoning

At least 1 port from each server HBA should be zoned to communicate with a single Compellent fault domain. The result of this will be two distinct FC fabrics and four redundant paths per server. Round Robin or Fixed Paths are supported. Compellent Virtual Ports should be leveraged to minimize port consumption as well as

simplify deployment. Each controller's front-end virtual ports within a fault domain should be zoned with at least one ESXi initiator per server.



2.1.2 Local Tier 1 Storage

Choosing the local tier 1 storage option means that the virtualization compute servers use ten (10) locally installed 146GB 15k drives to house the user desktop vDisk images. In this model, tier 1 storage exists as local hard disks on the compute hosts themselves. To achieve the required performance level, RAID 10 must be used across all local disks. A single volume per local tier 1 compute host is sufficient to host the provisioned desktop VMs along with their respective write caches.

2.1.3 Shared Tier 1 Storage

Choosing the shared tier 1 option means that the virtualization compute servers are deployed in a diskless mode and all leverage shared storage hosted on a high performance Dell storage array. In this model, shared storage will be leveraged for tier 1 used for VDI execution. Based on the heavy performance requirements of tier 1 VDI execution, it is recommended to use separate arrays for tier 1 and tier 2 above 500 users for EqualLogic and above 1000 users for Compellent. We recommend using 350GB LUNs for VDI and running 50 VMs per volume to minimize disk contention. Sizing to 1000 basic users, for example, we will require 20 x 350GB volumes per array. Each volume should contain a VMware View replica.

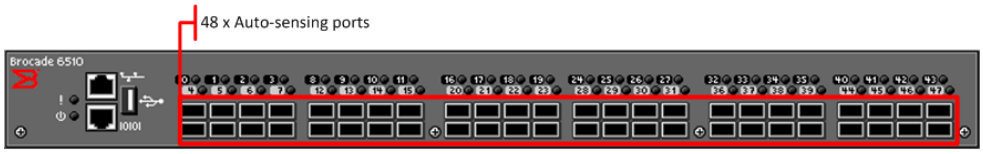
Volumes	Size (GB)	Storage Array	Purpose	File System
VDI-1	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-2	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-3	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-4	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-5	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-6	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-7	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-8	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-9	350	Tier 1	50 x desktop VMs + Replica	VMFS 5
VDI-10	350	Tier 1	50 x desktop VMs + Replica	VMFS 5

Fibre Channel Switching Options

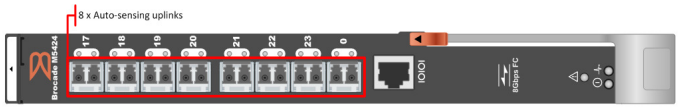
2.2.1 Brocade 6510 Fibre-Channel Switch

The Brocade® 6510 Switch meets the demands of hyper-scale, private cloud storage environments by delivering market-leading speeds up to 16 Gbps FC technology and capabilities that support highly virtualized environments. Designed to enable maximum flexibility and investment protection, the Brocade 6510 is

configurable in 24, 36 or 48 ports and supports 2, 4, 8 or 16 Gbps speeds in an efficiently designed 1U package. It also provides a simplified deployment process and a point-and-click user interface—making it both powerful and easy to use. The Brocade 6510 offers low-cost access to industry-leading Storage Area Network (SAN) technology while providing "pay-as-you-grow" scalability to meet the needs of an evolving storage environment.



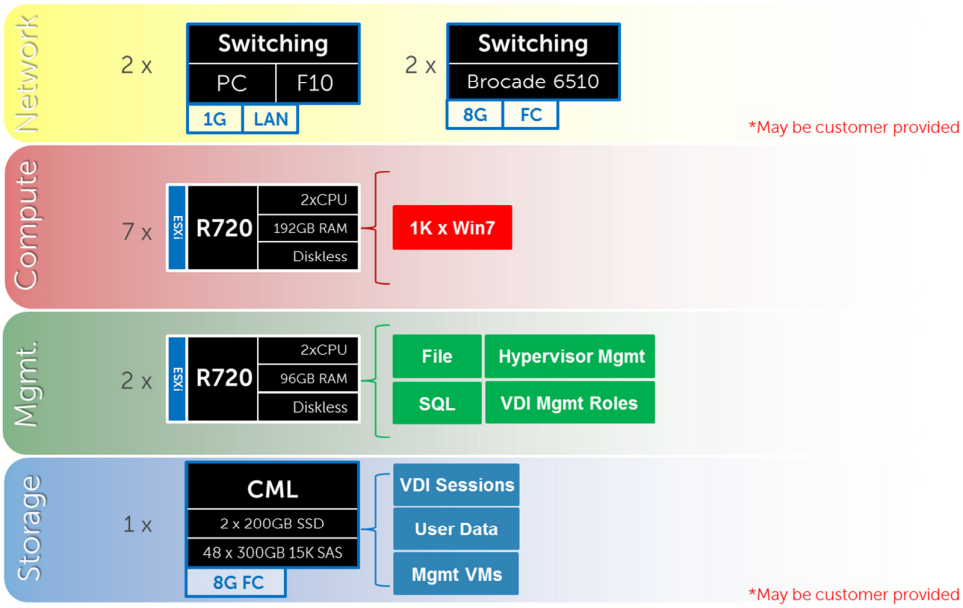
2.2.2 Brocade M5424 Blade Switch



The Brocade M5424 switch and the Dell™ PowerEdge™ M1000e blade enclosure provide robust solutions for FC SAN deployments. Not only does this solution help simplify and reduce the amount of SAN hardware components required for a deployment, but it also maintains the scalability, performance, interoperability and management of traditional SAN environments. The M5424 can easily integrate FC technology into new or existing storage area network (SAN) environments using the PowerEdge™ M1000e blade enclosure. The Brocade M5424 is a flexible platform that is ideal for large storage area networks, delivering advanced functionality, performance, manageability and scalability with up to 16 internal fabric ports and up to eight 2GB/4GB/8GB auto-sensing uplinks. Integration of SAN switching capabilities with the M5424 also helps to reduce complexity and increase SAN manageability.

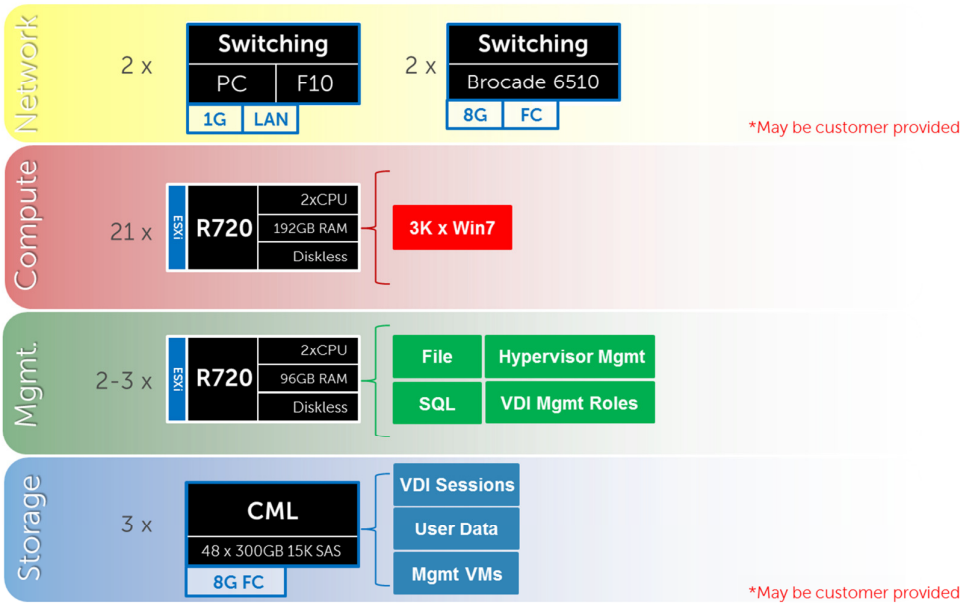
Shared Tier 1 – Rack – 1000 Users (FC – Compellent)

Utilizing Compellent storage for shared tier 1 provides a FC solution where tier 1 and tier 2 are functionally combined in a single array. Tier 2 functions (user data + Mgmt VMs) can be removed from the array if the customer has another solution in place. Doing this should net an additional 30% resource capability per Compellent array for user desktop sessions.



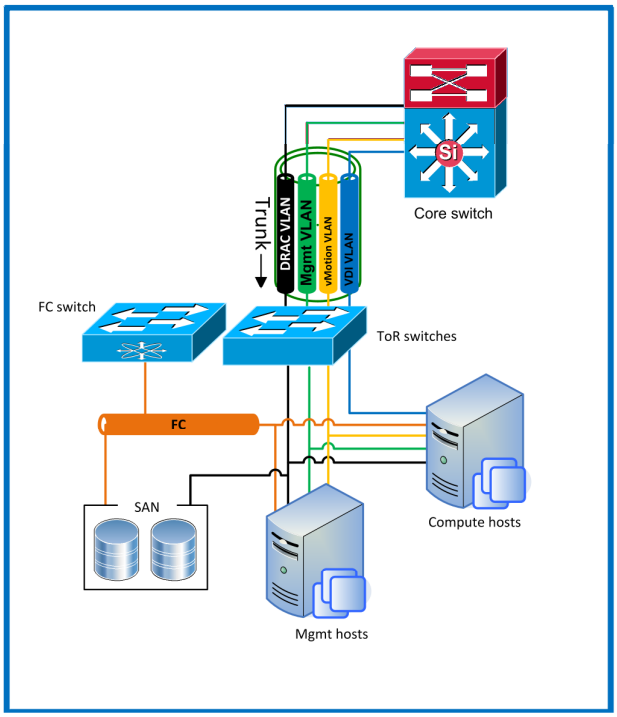
Shared Tier 1 – Rack (FC – Compellent)

FC is also supported in this model with discrete Compellent arrays in tier 1 and tier 2. The Brocade 6510 is the FC switch of choice using 8Gb along with 8Gb FC IO cards in the Compellent array.



2.4.1 Shared Tier 1 Rack – Network Architecture (FC)

In the Shared tier 1 architecture for rack servers using FC, a separate switching infrastructure is required for FC. Management and compute servers will both connect to shared storage using FC. Both management and compute servers connect to all network VLANs in this model. All ToR traffic has designed to be layer 2/switched locally, with all layer 3/routable VLANs routed through a core or distribution switch. The following diagrams illustrate the server NIC to ToR switch connections, vSwitch assignments, as well as logical VLAN flow in relation to the core switch.

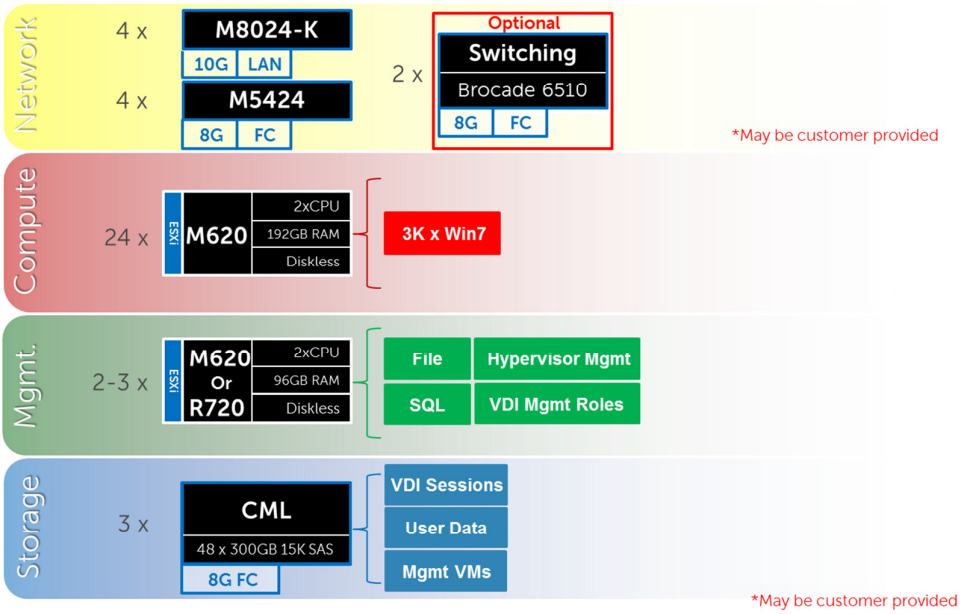


2.4.2 Shared Tier 1 Rack Scaling Guidance (FC)

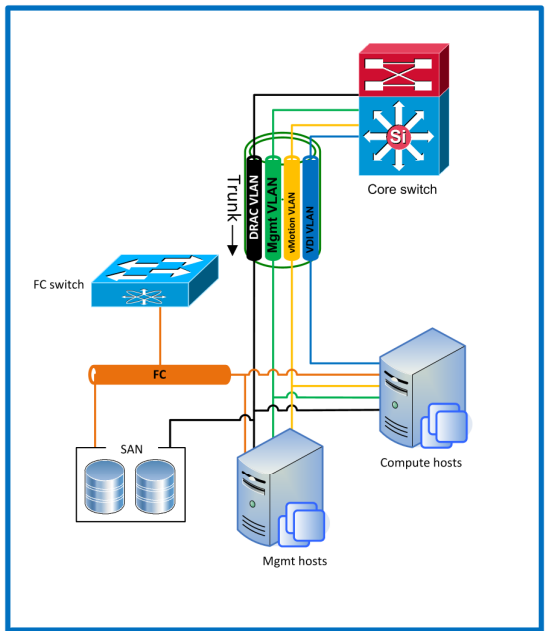
Shared Tier 1 HW scaling (Rack - FC)					
User Scale	**LAN Network**	**FC Network**	**CML T1**	**CML T2**	**CML NAS**
0-1000	S55	6510	15K SAS	-	-
0-1000 (HA)	S55	6510	15K SAS	NL SAS	FS8600
1000-6000	S55	6510	15K SAS	NL SAS	FS8600
6000+	S60	6510	15K SAS	NL SAS	FS8600

Shared Tier 1 – Blade (FC – Compellent)

FC is again an option in Shared tier 1 using blades. There are a few key differences using FC with blades instead of iSCSI: Blade chassis interconnects FC HBAs in the servers, and there are FC IO cards in the Compellent arrays. ToR FC switching is optional if a suitable FC infrastructure is already in place.



2.5.1 Shared Tier 1 Blade – Network Architecture (FC)



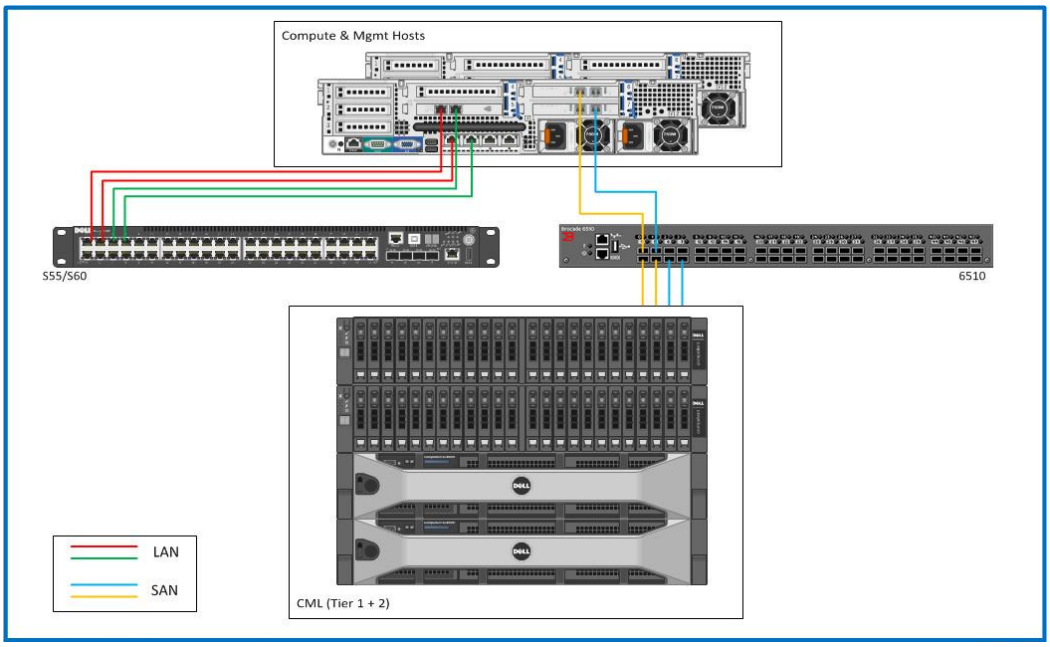
2.5.2 Shared Tier 1 Blade Scaling Guidance (FC)

Shared Tier 1 HW scaling (Blade - FC)						
User Scale	Blade LAN	Blade FC	ToR FC	CML T1	CML T2	CML NAS

0-500	8024-K	5424	6510	15K SAS	-	-
500-1000	8024-K	5424	6510	15K SAS	-	-
0-1000 (HA)	8024-K	5424	6510	15K SAS	NL SAS	NX3300
1000-6000	8024-K	5424	6510	15K SAS	NL SAS	NX3300
6000+	8024-K	5424	6510	15K SAS	NL SAS	NX3300

Cabling Diagrams

2.5.3 Shared Tier 1 Cabling (Rack – Compellent)



2.5.4 Shared Tier 1 Cabling (Blade – Compellent)